Environmental Policies and Industrial Competitiveness: The Choice of Instrument

Nick Johnstone

ENVIRONMENTAL ECONOMICS PROGRAMME

Gatekeeper

GK 99-01

August 1999

International Institute for Environment and Development

IIED is an independent, non-profit organisation which seeks to promote sustainable patterns of world development through research, policy studies, consensus building and public information. Established in 1971, the Institute advises policy makers and supports and collaborates with Southern specialists and institutions working in similar areas.

Environmental Economics Programme

The Environmental Economics Programme (EEP) seeks to develop and promote the application of economics to environmental issues in developing countries. This is achieved through research, policy analysis and capacity strengthening activities, focusing on the role of the environment and natural resources in economic development and poverty alleviation.

Gatekeeper Series

The Gatekeeper Series, which is aimed in particular at field staff, researchers and decision-makers, highlights key topics in the field of environmental and resource economics. Each paper reviews a selected issue of contemporary importance and draws preliminary conclusions of relevance to development activities. References are provided to important sources and background material.

The Author

Nick Johnstone is a Research Associate in the Environmental Economics Programme at the International Institute for Environment and Development, London. He may be contacted at:

Environmental Economics Programme
IIED
3 Endsleigh Street
London WC1H 0DD
UK

Tel: **(44) 0171 388 2117**
Fax: **(44) 0171 388 2826**
Email: **enveco@iied.org**

Acknowledgements

This paper was presented at the conference on “Environmental Regulations, Globalisation of Production and Technological Change” held at the University of East Anglia 1-2 July 1999. The author would like to thank the conference participants for their valuable comments. Support for the publication of this paper was provided by the Swedish International Development Authority (SIDA).

Environmental Policies and Industrial Competitiveness: The Choice of Instrument

Nick Johnstone

Abstract

The empirical literature on the international competitiveness effects of environmental policy is large and expanding. However, there are few studies that actually look at the competitiveness effects of different types of regulation. This is significant since the economic effects of a regulation may be more a function of its nature in an institutional sense than its stringency in terms of emissions abated. Some of these issues are explored in this paper, looking at the effects of different direct forms of regulation (mandated emission reductions and technology-based standards) and market-based instruments (emission taxes and tradeable permits) on competitiveness.

1. Introduction

The empirical literature on the international competitiveness effects of environmental policy is large and expanding (see Adams 1997 and Jaffe *et al* 1995 for recent reviews). In general, such studies have not found a statistically significant negative relationship between the stringency of environmental regulations and international trade and investment patterns (see Tobey 1990, Grossman and Krueger 1992, and Kalt 1988).

However, there are exceptions, with some sectors and some particular trading relationships revealing limited (and ambiguous) evidence of a negative relationship (see Han and Braden 1996, van Beers and van den Bergh 1996 and Xing and Kolstad 1996 for examples). Moreover, studies conducted at the national level have generally found more evidence of competitiveness effects in so far as they are reflected in firm profitability or sectoral productivity (see Gray and Shadbegian 1995 and OTA 1994).

While these studies examine the effects of the relative stringency of environmental regulations on competitiveness (usually using abatement costs as declared by firms in industrial surveys as the explanatory variable), there are few studies, which actually look at the competitiveness effects of different types of regulation (Bartik 1988 and McConnell and Schwab 1990 are notable exceptions). This is significant since the economic effects of a regulation may be more a function of its nature in an institutional sense than its stringency in terms of emissions abated.

In this paper I will explore some of these issues, looking at the effects of different direct forms of regulation (mandated emission reductions and technology-based standards) and market-based instruments (emission taxes and tradeable permits) on competitiveness. However, addressing the issues related to competitiveness is a thorny issue, not least because defining competitiveness is inherently problematic. This is particularly true at the level of the nation-state rather than the firm or sector. As such, in this paper, I concentrate in a rather general way on a number of factors which most commentators agree are likely to affect the ability of firms to reduce production costs, increase market share, and innovate in terms of production processes and product development.

In this vein, Section 2 reviews the effects of different regulations on direct compliance costs. Section 3 discusses the importance of the type of cost affected. Section 4 reviews differences in incentives for innovation in abatement technologies and their diffusion. Section 5 discusses the role of regulations as barriers to entry, allowing for the exclusion of potential rivals and potentially slowing down technological change. Finally, Section 6 looks at the role of different regulations on the demand-side, through product differentiation.

2. Policy Choice and Aggregate Compliance Costs

In terms of direct compliance costs for the firm there are two primary factors which determine the costs of compliance:

- Potential Efficiency Gains
- Extent of Financial Responsibility for Payment for Residual Emissions

In general, the effect of different regulations on the first is straightforward. Economic instruments (permits and taxes) generate efficiency gains insofar as abatement costs are equalised across firms. Direct forms of regulation (technology-based and emission limits) do not do so (although in rare cases direct regulations can mimic the "static" effects of economic instruments by tailoring requirements to firm-level differences in initial abatement costs. Selective application of differentiated technology-based standards in the US is one such case.) The potential efficiency benefits of the use of economic instruments are considerable.

Using abatement cost estimates from Hartman *et al* (1994) based on US Census Bureau data it is possible to draw a more general picture of the degree of heterogeneity (and thus inefficiency) which existed in American pollution control regimes in the mid-1980s. Figure 1 shows the frequency distribution of marginal abatement costs in 1983-1985 for four classes of air pollutant (particulates, SO_x/NO_x, CO, hydrocarbons). On this basis it is clear that there was considerable inefficiency in the American air pollution control regime in the mid-1980s. (Note that for local and regional pollutants some of the differences may be explained by differences in damages per unit of emission, which implies that an "efficient" distribution would be heterogeneous. However, it is unlikely to result in such a wide dispersion.) Given that there has been only limited substitution of direct regulations by more efficient (i.e. MAC-equalising) regimes it is quite likely that heterogeneity of a comparable order still exists. Moreover, if there is considerable variation in MACs within individual sectors these figures will underestimate the potential benefits.

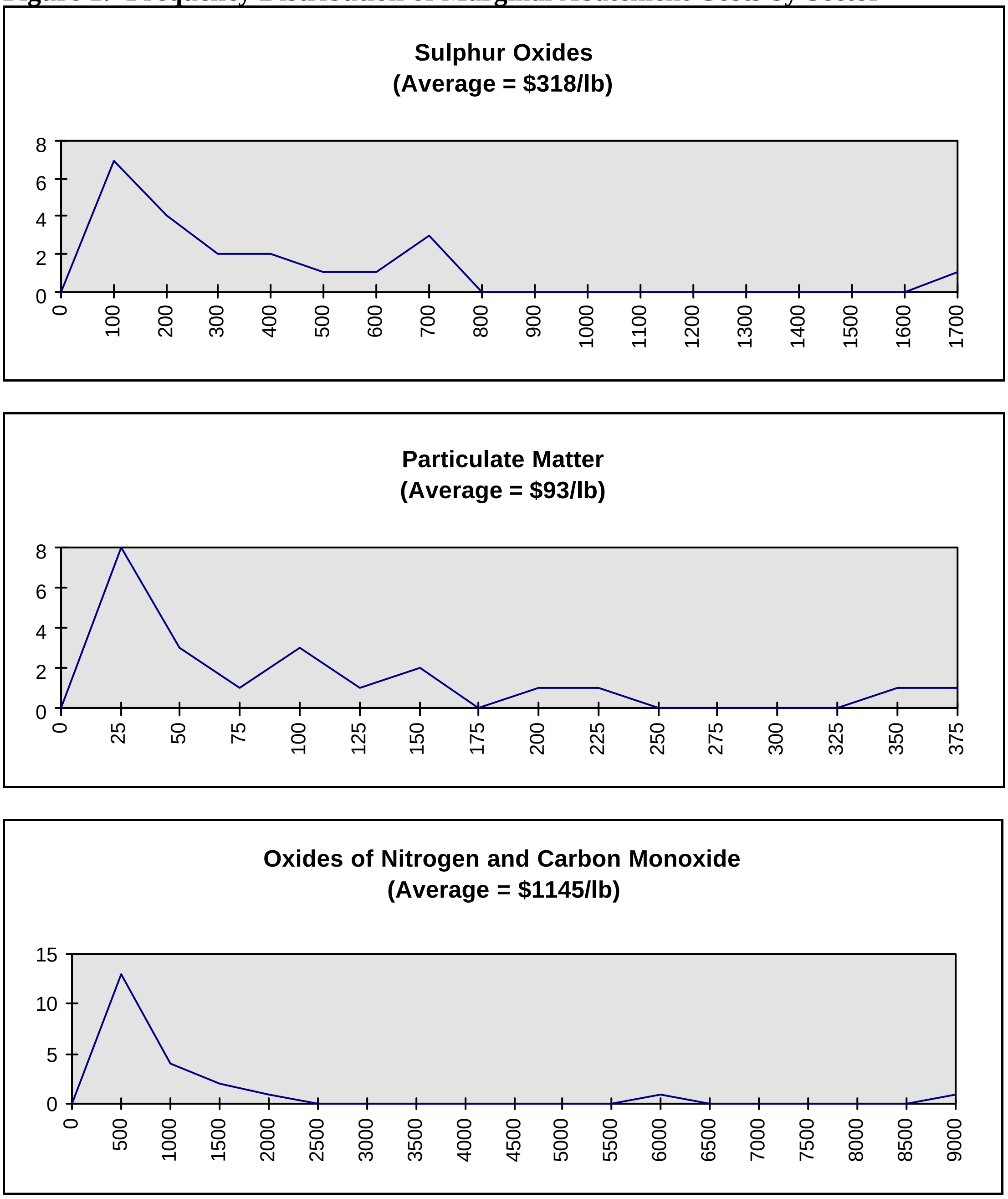
However, at the level of the firm (rather than the economy in general), perhaps a more important factor is the extent to which firms bear financial responsibility for residual emissions. On this basis, the advantages of market-based instruments for the firm are less clear. While most direct forms of regulation "zero-charge" residual emissions (i.e. unabated emissions), economic instruments do not tend to do so. The difference is likely to be most significant when the environmental target is lax and the marginal abatement cost curve is elastic since in such cases tax/permit expenditures will represent a high proportion of total compliance costs. Thus, unless efficiency gains are considerable firms will tend to prefer direct forms of regulation.

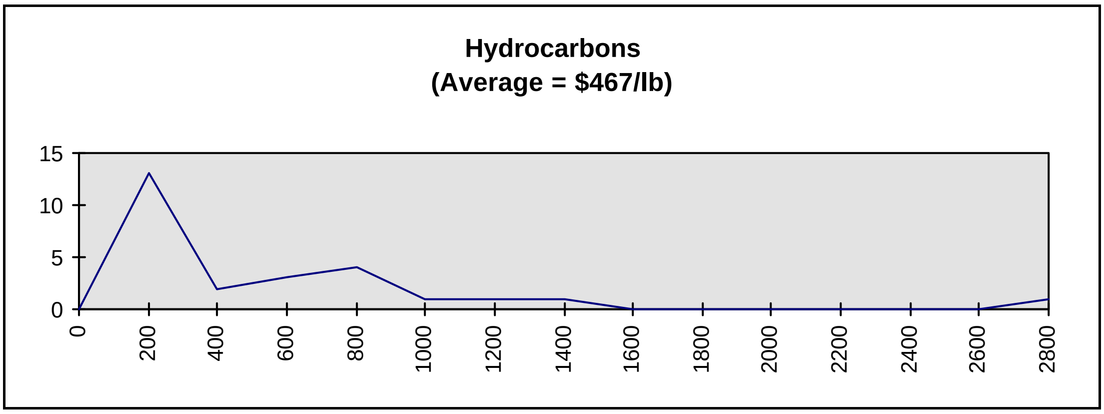
The exception is, of course, grandfathered permits. In such cases firms (in aggregate) will not pay for residual emissions. Indeed, even without measuring the efficiency gains, net sellers may do better than under direct forms of regulation. Including both permit expenditures and abatement costs, firms that are initially furthest from the equilibrium permit price have the most to gain since those firms whose initial abatement costs are the same as the equilibrium permit price will not realise any efficiency gains.

Table 1: Cost Effects of Alternative Environmental Policy Instruments

	Grandfathered Permits	Auctioned Permits	Emissions Tax	Mandated Emission Reductions	Technology-Based Regulation
Pay for Residual Emissions	No (in aggregate)	Yes	Yes	No	No
Abatement Cost Efficiency Gains	Yes	Yes	Yes	No (in most cases)	No (in most cases)

Figure 1: Frequency Distribution of Marginal Abatement Costs by Sector





The preceding discussion of the net effects for firms under taxes and auctioned permits is only “partial”, having concentrated on *direct* financial effects in terms of permit expenditures and abatement costs. This is significant, since a partial analysis implies that under a tax or an auctioned permit system, firms bear the full costs of permit expenditure, but do not reap any of the benefits associated with increased government revenues arising from the permit sales. In terms of economic competitiveness, this omission is important at the level of the firm, the sector, and the national economy. On the one hand, in the event that revenue recycling reduces distortions in the economy, it will have the effect of making the economy more competitive generally (see Bohm 1997, Goulder *et al* 1997, and Parry *et al* 1997). This debate is long and exceedingly technical and will not be discussed here.

On the other hand, the means by which the revenues are recycled will also affect competitiveness at the level of the firm and the sector, generating quite different effects. In general, those firms which are relatively intensive in the use of the emissions taxed (or permitted) will lose, while firms which are intensive in the use of those factors of production whose tax rates are lowered will gain. Thus, ignoring the aggregate efficiency benefits of policies that raise revenue, the effects are primarily distributional. If there are specific concerns about the effects on individual sectors (e.g. adjustment costs), the revenues from a tax or an auctioned permit system might be specifically targeted to reduce competitiveness effects for firms with high compliance costs. However, it is important that this does not reduce incentives for abatement (e.g. tax exemptions).

Once again the case of grandfathering permits is interesting. To some extent, it might be analogous to giving vulnerable firms generous initial allocations under a grandfathered system, which would be an effective way of ensuring that distributional concerns are addressed without undermining the environmental effectiveness of the measure. Even if firms are grandfathered permits there will be an opportunity cost associated with their retention (profits foregone), and as such incentives for abatement will remain the same. However, it is important to note that the effects would be quite different relative to taxes and auctioned permits with government recycling of revenue. Grandfathering permits is a way of redistributing *rents*, while lowering other tax rates is a way of reducing *costs*.

This can be illustrated by drawing upon a study of carbon abatement in Canada. Holling and Somerville (1998) compare the effects of auctioned permits/emission taxes[1] relative to grandfathered permits. The sectoral effects of the grandfathered allocation and the auctioned allocation can then be compared. Ranking the sectors in ascending order of percentage changes in value-added under the grandfathered allocation, relative to the "business as usual!" scenario in 2010, it is clear that there are very different effects under the two schemes (Table 2). The Spearman rank correlation coefficient between the two is only 0.46. Depending on relative carbon-intensity and existing tax burdens, some sectors fare very differently under the two allocations: furniture and fixtures (5 and 28), wood products (9 and 24), retail trade (11 and 29), non-metal minerals (15 and 5), non-metal mining (16 and 3), chemicals (20 and 11), forestry (27 and 8), miscellaneous manufacturing (28 and 13), transportation and storage (29 and 10). In ten sectors, the sign for the change in value-added actually changes, depending on which allocation mechanism is used.

[1] They try to avoid "second-guessing" likely governmental responses to increased revenue from auctioned permits or taxes by positing a "neutral" scenario in which tax rates are reduced in proportion to the revenue presently raised by each tax.

Table 2: Sectoral Effects of CO_2 Stabilisation in Canada (% Change in Value Added)

	Grandfathered Allocation		Auctioned Allocation	
	% Change	**Rank**	**% Change**	**Rank**
Petroleum & Coal	-15.3	1	-14.4	1
Other Utilities	-13.1	2	-12.3	2
Mineral Fuels	-7.0	3	-6.1	4
Wholesale Trade	-4.2	4	-4.8	7
Furniture & Fixtures	-3.7	5	1.9	28
Electr. Products	-3.6	6	-5.4	6
Machinery	-3.1	7	-3.8	9
Electr. Power	-3.0	8	-2.2	15
Wood	-2.7	9	0.5	24
Construction	-2.4	10	-2.2	14
Retail Trade	-2.4	11	2.2	29
Communications	-2.3	12	-1.5	17
Serv. to Mineral Extraction	-1.9	13	-1.1	18
Fab'd Metals	-1.8	14	-3.7	12
Minerals except Metals	-1.8	15	-5.6	5
Non-metal Mining	-1.6	16	-8.1	3
Rubber and Plastic	-1.6	17	-1.6	16
Finance and Insurance	-1.5	18	1.7	26
Printing and Publishing	-1.2	19	0.9	25
Chemicals	-1.1	20	-3.7	11
Agriculture	-0.6	21	0.5	23
Comm., Bus. & Pers. Services	-0.6	22	3.4	30
Primary Metals	-0.5	23	-0.3	19
Transp. Eqpmt	-0.5	24	6.1	31
Paper and Allied	-0.4	25	0.3	22
Food, Bev's and Tobacco	-0.2	26	1.7	27
Forestry	-0.1	27	-4.4	8
Misc. Manuf.	-0.1	28	-2.5	13
Transp & Storage	-0.1	29	-3.8	10
Fishing and Trapping	0.0	30	0.0	20
Leather, Textiles and Apparel	0.8	31	9.7	32
Metal Mining	1.2	32	0.3	21

3. Policy Choice and Cost Categories

Environmental policy instruments differ not only in terms of aggregate costs of compliance, but also in terms of the nature of the costs affected. This can be illustrated taking the example of SO_2 emissions. In theory, countries could adopt (and have adopted) a variety of strategies in order to try to reduce damages:

- Mandated use of coal scrubbers (EU's LPCD)
- Restrictions on the use of high-sulphur coal
- Increased stack height in vulnerable regions
- Differentiated taxation on fuels

- Tradeable SO_2 permits or taxes (US's Acid Rain Program).

The first three types of regulation are prescriptive in nature. Some of these will principally affect capital costs (e.g. stack height) and some will affect operating costs (e.g. use of low-sulphur coal). Perhaps more commonly, some regulations will have an appreciable effect on both (e.g. sulphur scrubbers increase both capital costs and operating costs). Conversely, those instruments which are discretionary (e.g. leave compliance strategies in the hands of the firm), will affect different firms' cost structures differentially as they adopt strategies which best suit their needs. For instance, when the US Acid Rain Program was introduced firms adopted a variety of different strategies (see Table 3). It is significant that very few firms complied through the use of the technology which had been mandated previously (scrubbers), although this is partly a reflection of the nature of the existing capital stock. Data on strategies adopted by new plants would be more revealing.

Table 3: Compliance Strategies of Firms under the US Acid Raid Programme (% of Emissions)

	Rico (1995)	EIA (1994)
Low-Sulphur Coal	63	59
Permits	9	15
Scrubbers	11	10
Pre-Phase I Compliance	15	10
Fuel Switching	1	3
Retire Plant	1	2

With perfect financial markets, malleable fixed capital equipment, and/or a firm time-horizon which exceeds the life of the equipment, capital costs can be amortised in such a way that they have cost effects which are equivalent to operating costs. However, in practice such conditions do not hold, and the cost effects of different policy instruments of the same stringency will be very different. The associated competitiveness effects will differ correspondingly. In general, those measures that affect capital costs are much more likely to have an effect on firm exit (and perhaps relocation), while those measures that affect operating costs are more likely to have an effect on market share.

In one of the surprisingly few studies to look at this issue Markusen (1997) compares the effects of regulations which tend to impact upon capital costs and those which tend to impact upon marginal costs. Not surprisingly, he finds that the economic effects of regulations that impact on fixed costs tend to be reflected primarily in terms of firm entry and exit, while the effects of regulations that impact on variable costs tend to be reflected principally in terms of reduced levels of production per firm. This is significant since many technology-based rules tend to mandate specific technologies, which involve considerable fixed costs. (Not surprisingly, it is difficult to enforce regulations that affect operating costs.) Conversely, depending upon the optimal strategy adopted by firms, market-based instruments are more likely to affect variable costs to a much greater extent. In theory, this is also likely to be true of mandated emission reductions, although in many cases these are written so as to encourage the adoption of designated capital equipment.

4. Regulations and Abatement Technologies: Innovation and Diffusion

The importance of the regulatory framework in bringing about a technological trajectory that is less environmentally damaging has been noted. As far back as the mid-1970s it was pointed out that "...over the long haul, perhaps the most important single criterion on which to judge environmental policies is the extent to which they spur new technology towards the efficient conservation of environmental quality." (Kneese and Schultze 1975). This has important cost effects since a given level of emissions will be achieved at lower cost for those regulations, which spur innovation and diffusion. When the importance of "path-dependence" and "lock-in" are recognised, it is clear that the most important cost effects of different policy measures relate to their effects on incentives for innovation and diffusion (Kemp 1997).

While the case for market-based instruments (taxes, permits, deposit-refund schemes, etc...) relative to direct regulation (technology-based controls, performance standards, input bans, etc...) has usually been made in static terms, it is thought that the case is even more convincing when the dynamic effects in terms of technological innovation are examined. While many of the benefits of technological innovation are lost to the firm under more direct forms of regulation, under a market-based regime the firm itself is able to realise more of the economic benefits of technological innovation and adoption (see Downing and White 1986, Milliman and Prince 1989, Kemp *et al* 1992, and Nentjes and Wiersma 1987).

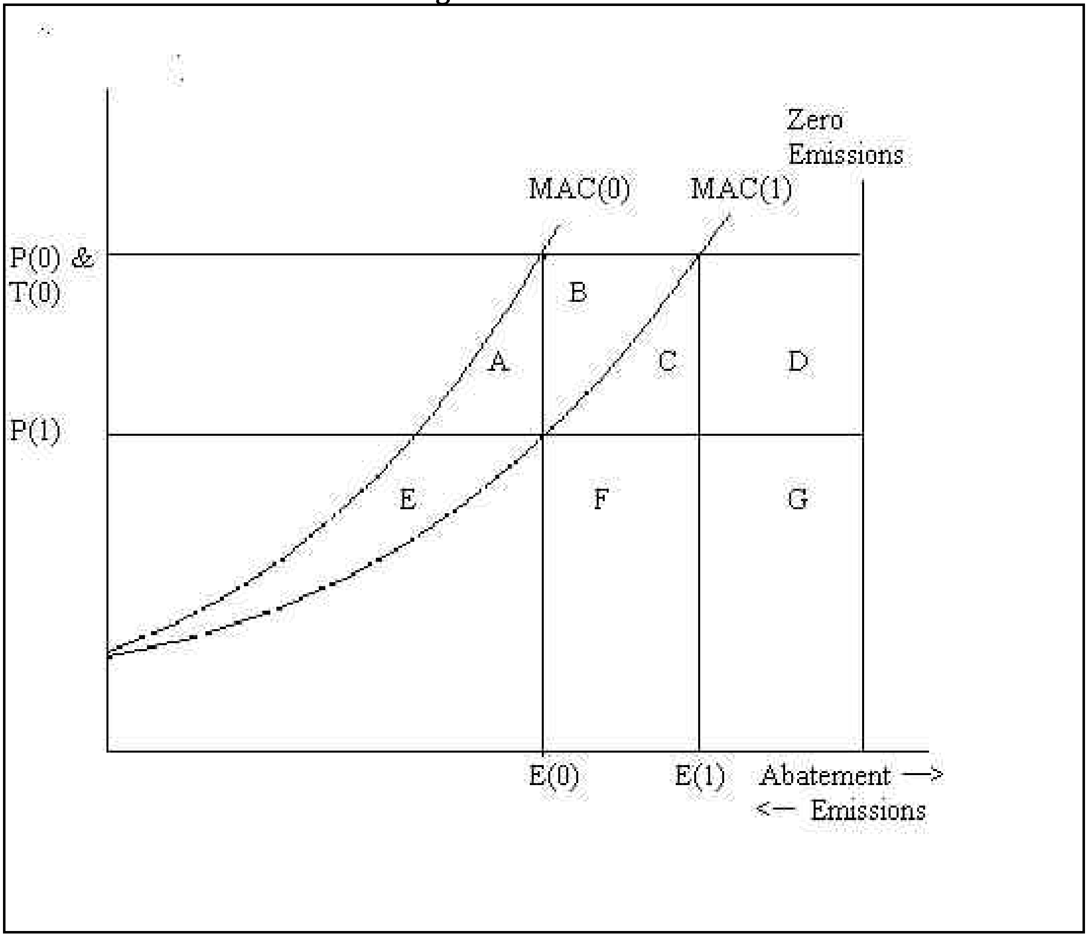
For instance, under technology-based standards, firms will have few incentives to innovate, unless they are confident that such innovations will result in changes in regulatory standards. While it is possible that this will give the innovator a temporary monopoly, this is an exceedingly risky strategy and as such technology-based standards certainly provide few incentives to innovate. Under mandated emission reductions there will be incentives to innovate (and to adopt innovations), but the cost savings will only be realised up to the point where emissions reach their mandated level (assuming that the mandated emission reduction is equal to E(0), the savings are equal to Area A+E in Figure 2). Since residual emissions are zero-charged there is no further incentive to innovate and adopt more efficient abatement technologies. Policy-makers try to circumvent this problem by mandating schedules for "technology-forcing" emission reductions which can only be met through innovation.

In general, market-based instruments perform better. However, different forms of market-based instrument may have different effects on the trajectory of abatement technologies. Milliman and Prince (1989) compare the effects of emission permits and taxes in terms of incentives to innovate and in terms of incentives to adopt innovations. They find that they have the same effects in terms of incentives to innovate (as reflected in terms of net benefits), and are superior to direct regulation. In this case the savings are equal to E+A+B.

However, market-based instruments may have very different effects in terms of incentives for innovators to encourage diffusion. While taxes and subsidies perform well, the effects of the two permit systems are very different, with auctioned tradeable permits having much stronger incentives than grandfathered tradeable permits. This result arises because under an auctioned allocation the innovating firm will get the benefit of lower permit prices if other firms adopt the innovation. Under a grandfathered allocation the fall in permit price will benefit buyers, but hurt sellers. Since the innovating firm will have already adopted the innovation, it is likely to be a net seller. As such it will lose from the diffusion of the innovation since this will drive down the permit price.

This can be seen in Figure 2, where an innovation leads to a reduction in abatement costs from MAC(0) to MAC(1), shifting from the initial equilibrium to the new equilibrium 1. Since the innovating firm is not large enough to behave as a price-setter the permit price will remain the same. However, if the innovating firm allows for the diffusion of the innovation it will drive down the permit price in the market, and thus shift down its own marginal abatement cost curve to equilibrium 2. If the firm has an initial grandfathered permit allocation equal to its initial level of emissions (E(O)) then it will not seek to diffuse the innovation since in doing so the gains from reduced abatement costs will be exceeded by the loss in payment receipts.

Figure 2: The Effects of Alternative Policy Instruments on Incentives to Innovate and Diffuse Abatement Technologies



Overall, the loss will be equal to the area if it allows for the diffusion of the innovation since its abatement costs will have fallen (by area C+F), but its permit receipts will have fallen by more (area B+C+F). Conversely, under an auction system it will gain overall if it diffuses the innovation since its abatement costs will fall by the same amount as under a grandfathered system (C+F), but permit payments will fall (rise) by area D-F. Thus, the effects will depend upon the innovating firm's initial allocation, but will in any case be less than under an auctioned allocation.

However, if the innovations are patented, then the positive effect of royalty payments arising from diffusion will certainly far outweigh any negative permit price effects for permit sellers under a grandfathered allocation. Moreover, much of the literature assumes that innovations are internal to the sector - i.e. generated by firms which emit the permitted pollutants. This is not always (or even usually) the case. Thus, the differences between the effects of different allocations under tradeable permit systems is certainly less than the difference between tradeable permits systems in general and direct forms of regulation.

The more general belief in the ability of market-based instruments to stimulate abatement innovation has been borne out by some of the tradeable permit systems actually introduced. The most telling example is certainly the SO_2 allowance trading programme. Under the Clean Air Act's rules, firms effectively only had one option for reducing emissions: i.e., to install scrubbers. The allowance trading programme allowed firms more flexibility in their choice of abatement options such as switching fuels, buying low-sulphur coal and buying permits. Thus, it introduced innovation in the sense that firms adopted technologies that they had not adopted previously.

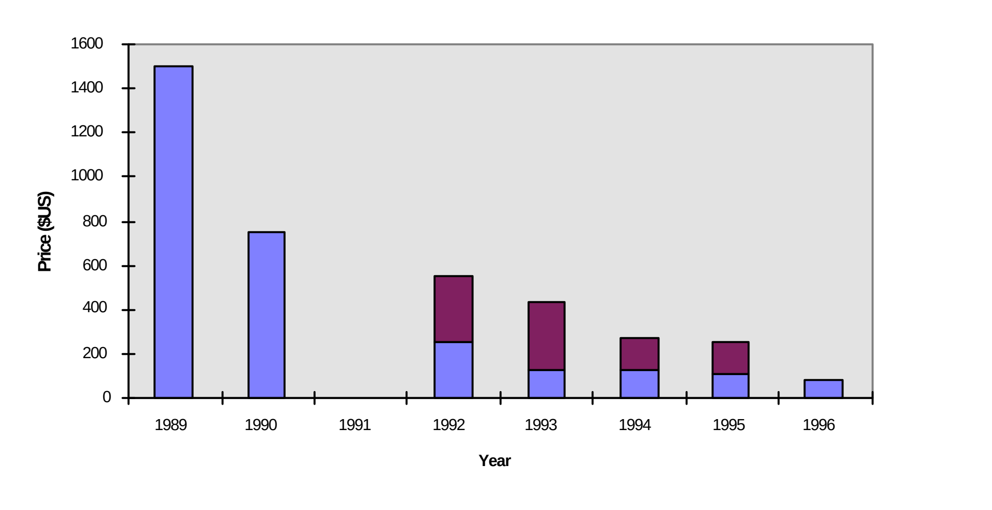
However, it also introduced more fundamental innovations. On the one hand, since the inauguration of the tradeable permit system, technological improvements have allowed the price of scrubbers to drop significantly. In 1995, the capital cost of a scrubber sufficient for a 639 MW plant cost less than a scrubber half this size in 1989 (see Burtaw 1996 and Bohi and Burtaw 1997). On the other hand, there have been improvements in fuel-mixing technologies allowing firms to shift towards lower-sulphur mixes in a more cost-effective manner. Finally, the costs of transporting low-sulphur coal from the Powder River Basin have fallen, although this is due mainly to institutional and not technological factors.

All of these developments arose because firms now had to compete in the market against other abatement options. Previously there had been no incentive to innovate, unless it was felt that in doing so the regulators would respond and change the technology-based rules[2] (see also Ellerman and Montero 1996). In light of this, abatement costs plummeted. Figure 3 traces SO_2 allowance prices and shows how important these effects can be (Bohi and Burtaw 1997).

Thus, in general there seems to be little question that market-based instruments provide better incentives for abatement technology innovation and diffusion than direct regulation. They will, therefore, have positive competitiveness effects, since a policy which pushes firms onto a technological trajectory which allows them to meet given environmental objectives at lower cost is likely to be more important than the costs borne by the firm in the first instance.

[2] In fact, as noted above, if rules are technology-based, the incentive for the innovator would be greater if the firm is certain that it will generate a rule change. This arises since the innovator's rents are protected by the patent (as under alternative policies) *and* the market is guaranteed by the rule (unlike under alternative policies). However, this seems unlikely, and the innovating firm would face considerable risk in undertaking the investments necessary.

Figure 3: SO_2 Allowance Prices[3]



[3]Figures for 1989-1990 are *ex ante* estimates and the shaded region for 1992-1995 gives the range of prices.

5. Capital Turnover, Firm Entry and Insider Rents

Perhaps more significantly, some regulations may restrict the entry of new firms into the market. This may have more far-reaching consequences for competitiveness, since new firms are often important instigators of new products and production processes. (See Geroski 1991 and Baldwin 1995 for very full treatment of the role of firm entry in the dynamics of the economy.) Thus, barriers to entry related to regulatory measures may reduce competitiveness by slowing down both the rate of technological change and the rate of product development. Barriers to entry can arise from both direct forms of regulation and market-based instruments. (They are also a pervasive problem in "voluntary" measures such as "eco-labelling" and negotiated agreements.) Two cases in particular will be reviewed and discussed in turn:

- New Source Bias in Technology-Based Regulations
- Tradeable Permits and Market Power.

A number of existing regulatory regimes have an explicit bias against potential new sources of emissions. For instance, under the EPA's 1970 Clean Air Act regulations new firms often have to introduce a higher standard of technology relative to existing emitters. Major new sources in attainment areas have had to invest in BACT (relative to no requirements for existing sources), while major new sources in non-attainment areas have had to invest in LAER (relative to RACT for existing sources). Even more recent amendments have preserved this bias. For instance, under the Emissions Trading Programme, the use of "bubbles" was prohibited for new firms and they were constrained in their opportunities to purchase offsets.

Such biases provide incentives for firms to keep existing plants open and discourage the introduction of new plant. This can result in a significant slow-down in the turnover of capital equipment. For instance, it has been estimated that biases in the Clean Air Act have resulted in a rise in the average age of electricity-generating capital equipment. (See Maloney and Brady 1988. See also Nelson *et al.* 1993 for a discussion.) For instance, while new electricity generating plants had to introduce equipment consistent with "Lowest Achievable Emission Reductions" (LAER), existing plants only had to meet less stringent standards. Significantly, due to the nature of the regulatory standards, this slow-down is likely to rise more linearly as stringency is increased. Thus, non-attainment zones will have particularly long-lived capital equipment. Due to the close relationship between capital turnover and emission reduction, this can have perverse environmental effects, reducing the environmental benefits of the regulations (see Table 4). More significantly for this discussion, it can have long-term economic costs, providing incentives for firms to keep obsolete capital in operation.

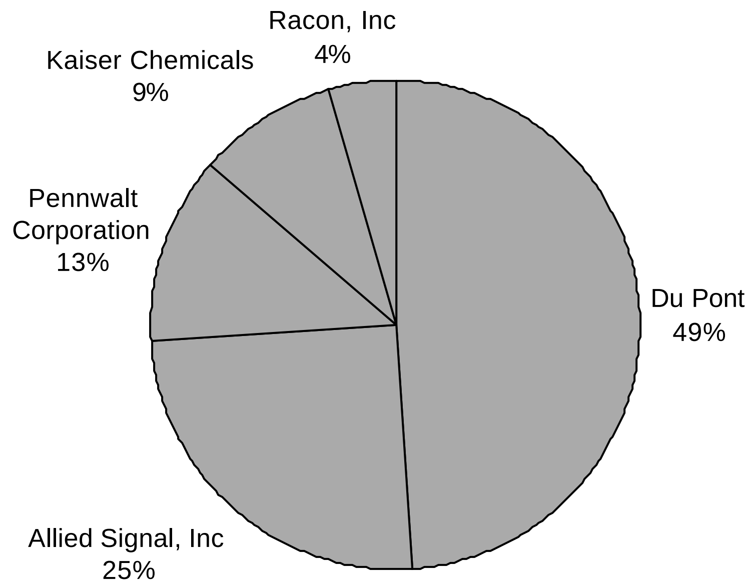
Table 4: Effect of CAA Regulations on Electricity Generating Capital Stock

Effect of Regulations on the Capital Stock of States with Greater than Average Regulatory Expenditures	
Age of Capital Relative to States with Less than Average Regulatory Expenditures	44% higher
Effect of Regulations on Capital Turnover in Year	8.1 years longer
Effect of Reduced Turnover on Emission Rates	27% higher

Tradeable permits may also generate barriers to entry. Firms with power in the market for permits may be able to exclude potential rivals from their market, thereby securing a degree of power in product markets (Misiolek and Elder 1989). In effect, there is a danger that permits may become the vehicles through which existing firms are able to exercise market power in product markets by excluding other firms. This is quite distinct from taxes, since no market is created, and thus there is no vehicle through which power can be exercised.

What are the conditions necessary for there to be exclusionary behaviour in the market for permits? Most importantly, there must be some degree of concentration of emission sources. If no firms are important players in the market (whether as buyers or sellers) there is little likelihood of there being any market power. Thus, in the discussions concerning the introduction of the CFC trading programme it was feared there was significant potential for market power to be exercised since production of CFCs was so concentrated in the United States (see Figure 4). In the end, permits were issued to 27 firms. The problem could have been mitigated through the inclusion of downstream users who were, after all, the ultimate emitters of CFCs.[4] (See Hahn and McGartland 1989 and Tietenberg 1998.)

Figure 4: CFC Production in the United States in 1986 (Percentage of Total Production)



While CFCs are a global pollutant, the likelihood of market power being exercised is even more likely if the permit trading programme is localised (e.g. local air and water pollutants), since the programme will only cover a small number of firms. In the Fox River BOD case, the potential for market power is even greater than first appears, since the market is sub-divided to reflect "clusters" where pollution is most problematic. At two points, only six and seven firms are able to trade with each other (see Hahn 1989). Thus, in a simulation of the programme 90% of pollution rights are purchased by three firms and 44% by just one firm.

[4] Conversely, this would have increased the transaction and administrative costs of the programme considerably, which is why the regulators were reluctant to expand the programme.

It is a pre-condition for exclusionary behaviour that firms compete in both the market for permits and outputs since there is no benefit to be gained from excluding firms from markets in which the firm with market power does not compete. Thus, exclusionary behaviour is more likely for pollutants in which emissions (or at least permitted emissions) are highly concentrated in a few sectors and most firms in this sector are included in the systems. For instance, the danger of exclusionary behaviour in the market for CFCs was probably much greater than the danger of exclusionary behaviour in a market for carbon dioxide, even if the concentration of emissions amongst a few firms is as great. However, to some extent, this situation may arise through the rules of the programme itself. For instance, many programmes explicitly have the sectoral scope of potential traders.

What are the potential competitiveness effects of barriers to entry arising from new source biases and power in the market for permits? One of the few researchers to look at the effects of new firms on total factor productivity is Geroski (1989 and 1991). Although he finds that relatively few entrants can be characterised as “innovators” (in terms of products or processes), he feels that firm entry still has appreciable effects on innovation, both directly through the innovators themselves, and indirectly as a spur for insiders to innovate. He concludes that approximately 30% of productivity growth in the UK can be attributed to firm entry, and the effect is even greater in the long-run.

Looking directly at the relative productivity rates of new entrants and incumbents, Baldwin (1995) finds that as much as 29-30% of growth in total factor productivity in North America can be attributed to new firms and plants. Overall, plant turnover may be responsible for 40-50% of productivity growth. Some of these effects may be quite indirect. For instance, it is considered that new firms (or even the possibility of their entry) may also encourage more efficient use of given productive resources and spur innovation amongst incumbents (Geroski 1991).

6. Regulations and Demand-Side Effects

Thus far, the entire discussion has been carried out in terms of the effects of different regulatory instruments on the supply side, e.g., on regulated firms. However, competitiveness is not just a function of reduced costs, whether from static efficiency gains or dynamic technological benefits. Firms are also more competitive if they are able to capture a higher price for their output, and in this final section I will argue that regulations differ in their ability to allow firms to capture a higher market price.

On the one hand, the issue comes down to the extent to which different regulations differentiate products. If consumers attach a value to the environmental effects of its production or consumption then a measure which “advertises” this fact will help firms mitigate adverse cost effects, and perhaps even gain profitability, relative to a regulation which is equal in stringency and cost, but which does not “differentiate” the product. In a related vein, measures which are in some sense “voluntary” are also more likely to allow firms to capture market share or higher prices. This is because, since firms do not have any choice but to comply with mandatory regulations (or potentially face penalties for violations), the firm is not seen as playing an active role in bringing about reduced damages. This is not true of measures in which the firm can adopt different strategies.

Most obviously, measures such as certification systems and "eco-labels" are clearly relevant since they - by their very nature - differentiate products. Moreover, firms are free to seek certification or not, and as such those who do so are more likely to be seen as active instigators of environmental improvements than under mandatory regulations. There is evidence that programmes such as the European Union's Blue Angel recycling programme have allowed firms to capture market share and/or charge a premium price. The ISO environmental management system sells itself to prospective firms largely on this basis.

However, more pertinently for this discussion, regulations which are not explicitly information-based may differ in their effects, with some more readily lending themselves to product differentiation. In the US Acid Rain Program there was a relatively small number of firms which were the main buyers: Central Illinois Public Service, Illinois Power Company, Duke Power and Wisconsin Electric Power (Cole 1998). All of these were high abatement cost utilities which exploited the possibility of buying allowances above and beyond those which they had been grandfathered at a price lower than the abatement costs that would have otherwise been incurred. In 1995 and 1996, over 75% of all inter-utility purchases of permits were bought by one firm, Illinois Power (Ellerman *et al* 1996). However, there is evidence that their compliance strategy (buying permits) may have had adverse consequences for their public image. Ownership of a permit was, in effect, a negative "eco-label".

This is very different from other regulations. Mandated emission reductions and technology-based standards do not allow a firm to differentiate its product since compliance is given. In addition, tax-based regulations are unlikely to do so. While firms can adopt different compliance strategies, and thus may be able to try and differentiate their product on the basis of compliance strategy (e.g. invest in abatement equipment rather than pay for residual emissions), non-payment of emission taxes is not likely to have the same resonance as relative permit holdings. Permit markets are often well advertised public events in which buyers and sellers are known by NGOs and others concerned about the environment. It is difficult to imagine a tax-based policy according the same effect.

7. Conclusions

Much discussion has centred on addressing the question of whether or not environmental regulations adversely affect competitiveness. However, surprisingly little of this has looked explicitly at the issue of policy choice - i.e. what competitiveness effects are likely to arise from which different regulations. This is significant since the choice of instrument may be a more important factor than the level of stringency *per se*. This paper has explored some of these issues in a rather general way, reviewing the effects in terms of direct compliance costs, technological effects (abatement innovations and general capital turnover), and demand-side effects.

References

Adams, J. 1997. "Environmental Policy and Competitiveness in a Globalised Economy: Conceptual Issues and a Review of the Empirical Evidence" in *Globalisation and Environment: Preliminary Perspectives*. OECD, Paris.

Bain, J. 1965. *Barriers to New Competition*. Harvard University Press, Cambridge, Massachusetts.

Baldwin, J. R. 1995. *The Dynamics of Industrial Competition*. Cambridge University Press, Cambridge.

Barker, T. and N. Johnstone. 1998. "International Competitiveness and Carbon Taxation" in T. Barker and J. Kohler (eds.) *International Competitiveness and Environmental Policies*. Edward Elgar, Cheltenham.

Bartik, T. J. 1988. "The Effects of Environmental Regulation on Business Location in the United States" in *Growth and Change* 19(1):22-44.

Baumol, W and W. E. Oates. 1988. *The Theory of Environmental Policy*. Cambridge University Press, Cambridge.

Bohi, D. R. and D. Burtaw. 1997. *$S0_2$ Allowance Trading: How Experience and Expectations Measure Up*. Resources for the Future Discussion Paper 97-24. Washington, D.C.

Bohm, P. 1997. "Environmental Taxation and The Double Dividend: Fact or Fallacy?" in T. O'Riordan (ed.) *Ecotaxation*. Earthscan, London.

Burtaw, D. 1998. *Cost Savings, Market Performance, and Economic Benefits of the U.S. Acid Rain Program.* Massachusetts Institute of Technology CEEPR Discussion Paper 98-288. MIT, Cambridge, Massachusetts.

Cole, D. H. 1998. *New Forms of Private Property: Property Rights in Environmental Goods*. Indiana University School of Law, mimeo. Indianapolis.

Cramton, P. and S. Kerr. 1998. *Tradable Carbon Permit Auctions: How and Why to Auction Not Grandfather*. Resources for the Future Discussion Paper 98-34. Resources for the Future, Washington, D.C.

Downing, P. B. and L. J. White. 1986. "Innovation in Pollution Control". *Journal Of Environmental Economics and Management* 3:18-29.

Ellerman, D. A., and J.-P. Montero. 1996. *Why Are Allowance Prices So Low? An Analysis Of The S02 Emissions Trading Program.* Massachusetts Institute of Technology, CEEPR Working Paper 96-001. MIT, Cambridge, Massachusetts.

Geroski, P. A. 1989. "Entry, Innovation and Productivity Growth". *The Review of Economics and Statistics* 71:572-578.

Geroski, P. A. 1991. *Market Dynamics and Entry*. Blackwell Publishers, Oxford.

Goulder, L. H. 1994. *Environmental Taxation and the "Double Dividend": A Reader's Guide*. Working Paper 4896, National Bureau of Economic Research,. Cambridge, Massachusetts.

Goulder, L. H, Parry, I. W. H. and D. Burtaw. 1997. "Revenue-Raising Vs. Other Approaches To Environmental Protection: The Critical Significance of Pre-Existing Tax Distortions". *Rand Journal of Economics* 28:708-731.

Gray, W. B. and R. Shadbegian . *Pollution Abatement Costs, Regulations and Plant-Level Productivity*. Working Paper 4494, National Bureau of Economic Research, Cambridge, Massachusetts.

Grossman, G. M. and A. B. Krueger. 1992. "Environmental Impacts of a North American Free Trade Agreement". Discussion Paper No. 644, Centre for Economic Policy Research, London.

Hahn, R. W. 1989. "Economic Prescriptions for Environmental Problems: How the Patient Followed the Doctor's Orders" in *Journal Of Economic Perspectives* 3(2):95-114.

Hahn, R. W. and A. M. Mcgartland. 1989. "The Political Economy of Instrument Choice: An Examination of the U.S. Role in Implementing the Montreal Protocol". *Northwestern University Law Review* 83(3):592-611.

Han, K.-J. and J. B. Braden. 1996. *Environment and Trade: New Evidence from U.S. Manufacturing*. University of Illinois, Department of Economics, mimeo Urbana-Champaign.

Harrison. 1998. "Tradeable Permits for Air Pollution Control: The United States Experience" in OECD (forthcoming 1999) *Domestic Tradeable Permit Systems for Environmental Management: Issues and Challenges*. OECD, Paris.

Hartman, R. S., Wheeler, D. and M. Singh. 1994. *The Cost of Air Pollution Abatement.* World Bank Policy Research Working Paper 1398. Washington D.C.

Holling, C. and R. Somerville. 1998. *Impacts on Canadian Competitiveness of International Climate Change Mitigation*. Report prepared for the Canadian Ministry of International Trade. Toronto.

Jaffe, A. B., Peterson, S. R., Portney, P. R., and R. N. Stavins. 1995. "Environmental Regulation and the Competitiveness of U.S. Manufacturing: What Does the Evidence Tell Us?" *Journal Of Economic Literature* 33:132-163.

Johnstone, N. 1998. "Tradeable Permit Systems and Industrial Competitiveness: A Review of Issues and Evidence" in OECD (forthcoming 1999) *Domestic Tradeable Permit Systems For Environmental Management: Issues and Challenges*. OECD, Paris.

Kalt, J. P. 1988. "The Impact of Domestic Environmental Regulatory Policies on U.S. International Competitiveness" in M. Spence and H. A. Hazard (eds.) *International Competitiveness*. Harper and Row, Cambridge, Massachusetts.

Kemp, R. 1997. *Environmental Policy and Technical Change: A Comparison of the Technological Impact of Policy Instruments*. Edward Elgar, Cheltenham.

Kemp, R. e*t al.* 1992. "Supply and Demand Factors of Cleaner Technologies" in *Environment and Resource Economics* 2:615-634.

Keohane, N. O., Revesz, R. L. and R. N. Stavins. 1997. *The Positive Political Economy of Instrumental Choice in Environmental Policy*. Harvard University, John F. Kennedy School of Government, Cambridge, Massachusetts.

Kneese, A. and C. Schultze. 1975. *Pollution, Prices and Public Policy*. Brookings Institute, Washington, D.C.

Levy, D. L. 1997. "Business and International Environmental Treaties: Ozone Depletion and Climate Change" in *California Management Review* 39(3):4-71.

Maloney, M. T. and G. L. Brady. 1988. "Capital Turnover and Marketable Pollution Rights" in *Journal of Law and Economics* 31:203-226.

Markusen, J. R. 1997. "Costly Pollution Abatement, Competitiveness and Plant Location Decisions" in *Resource and Energy Economics* 19:299-320.

McConnell, V. D. and R. M. Schwab. 1990. "The Impact of Environmental Regulation on Industry Location Decisions: The Motor Vehicle Industry" in *Land Economics* 66(1): 67-81.

Milliman, S. R. and R. Prince. 1989. "Firm Incentives to Promote Technological Change. Pollution Control" in *Journal of Environmental Economics and Management* 17:247-265.

Misiolek, W. S. and H. W. Elder. 1989. "Exclusionary Manipulation of Markets for Pollution Rights" in *Journal of Environmental Economics and Management* 16:156-166.

Nelson, R. A., Tietenberg, T. H. and M. R. Donihue. 1993. "Differential Economic Regulation: Effects on Electric Utility Capital Turnover and Emissions" in *Review of Economics and Statistics* 75:368-373.

Nentjes, A. and D. Wiersma. 1987. "Innovation and Pollution Control" in *International Journal of Social Economics* 15:51-71.

Parry, I. W. H., Williams R. C., and L. H. Goulder. 1997. *When Can Carbon Abatement Policies Increase Welfare? The Fundamental Role of Distorted Factor Markets*. National Bureau of Economic Research, Working Paper 5967. Cambridge, Massachusetts.

Tietenberg, T. H. 1998. "Ethical Influences on The Evolution of the US Tradeable Permit Approach To Air Pollution Control" in *Ecological Economics* 24:241-257.

Tobey, J. A. 1990. "The Effects of Domestic Environmental Policies on Patterns of World Trade" in *Kyklos* 43(2):191-209.

United Kindgom Department of the Environment, Transport and the Regions. 1997. *Digest of Environmental Statistics*. HMSO, London.

United States Office of Technology Assessment. 1994. *Industry, Technology and The Environment.* US Government Printing Office (OTA-ITE-586), Washington D.C.

Van Beers, C. and J. C. J. M. Van Den Bergh. 1996. *The Impact of Environmental Policy on Trade Flows: An Empirical Analysis*. Rijks Universiteit, Department of Economics Research Memorandum 96.05. Leiden.

Wallace, D. 1995. *Environmental Policy and Industrial Innovation: Strategies in Europe, the US and Japan*. Earthscan, London.

Xepapadeas, A. 1997. *Advanced Principles in Environmental Policy*. Edward Elgar, Cheltenham.

Xing, Y and C. D. Kolstad. 1996. *Do Lax Environmental Regulations Attract Foreign Investment?* National Bureau of Economic Research Working Paper. Cambridge, Massachusetts.